1.4. SOUTH POLE OBSERVATORY

K. MCNITT

1.4.1. OPERATIONS

SPO is part of a larger U.S. Antarctic presence that works in conjunction with NSF and ASA to conduct research at the Amundsen-Scott South Pole Station. SPO is just one of many projects at the geographic South Pole where the elevation is 2835 m above sea level and the average temperature is -49°C.

Because airplanes can only land at the Pole during the relatively warm months of October through February, the station is physically "closed" for 8 months each year, with the exception of one mid-winter "airdrop" resupply in June. Data are transferred digitally via satellite throughout the year; however, air samples taken during the austral winter cannot be returned for analysis until the following spring. Of the 28 winterovers for the 1992-1993 season, four were NOAA employees. Along with the CMDL programs, ERL Environmental Technology Laboratory studied atmo-spheric boundary layer interactions and changes in relation to ozone-hole development.

Most of the CMDL projects are housed in the Clean Air Facility (CAF), an elevated building located 90 m grid northeast of the main station's fuel arch. As described in previous CMDL Summary Reports, the CAF is reaching its projected lifetime and is scheduled for replacement. Consequently, many upgrading projects for the CAF were left unresolved. But regardless of this, a concerted effort to improve the safety and efficiency of the current building was made.

Because the wind blows predominantly from the grid north or northeast, a "Clean Air Sector" has been designated into which excursions are prohibited without permission. This Clean Air Sector is marked and includes the area grid north of the CAF from 340° to 110°.

CMDL's meteorological instruments are mounted on the walk-up Met. Tower, less than 100 m from the CAF, and operations for the balloon program take place in three locations: the main station science building, the cargo arch, and the Balloon Inflation Tower (BIT).

Power outages were rare this year, but science demands continued to exceed "clean" power supplied by the CAF UPS. UPS-fed receptacles were identified and labeled to prevent accidental overloads, and the backup batteries were replaced. ASA electricians rewired the fire alarm system and rectified potentially dangerous wiring schemes in the building.

1.4.2. PROGRAMS

Table 1.6 is a summary of the measurement programs at SPO during 1993, and Table 1.7 is a discrete measurements summary the 1992-1993 winterover year.

Carbon Cycle Division

The Siemans continuous CO_2 analyzer ran without significant problems, although occasional repair of the chart recorder was necessary when the electronics were damaged by static discharge, and there was a period of several weeks at the beginning of the season when no chart paper was available.

Sample flask pairs were filled through the analyzer once per week and through a portable MAKS unit twice per month. The most significant improvement in the SPO carbon cycle program this year was the switch from the "greased connection" flasks to the flasks with Teflon valve seals. The analyzer manifold was modified to fill the new flasks in series, and the new MAKS unit required no modification.

Aerosols

The MRI four-wavelength nephelometer was off-line for 1 month at the beginning of the season while waiting for a replacement filter wheel motor; otherwise, the nephelometer and the TSI condensation nucleus counter ran continuously without extraordinary problems.

Discrete observations with the Pollak condensation nucleus counter took place twice daily for comparison with the TSI instrument.

Solar and Terrestrial Radiation

During the summer, all Eppley pyranometers, pyrgeometers, and the tracking pyrheliometer ran continuously without significant problems. Discrete observations with the filter wheel NIP took place three times daily. After sunset in March, the short-wave instruments were taken off-line for the winter. One up-facing and one down-facing pyrgeometer remained. The down-facing instrument was off-line for 5 months because of damage received during an apparent power surge.

Ozone and Water Vapor

The Dasibi ultraviolet absorbtion ozone monitor no. 322833 replaced instrument no. 5229 after 2 weeks of intercomparisons. The only remarkable problem with the new analyzer was the self-destruction of its pump that was replaced when small plastic shavings were discovered behind the exhaust outlet and the flow rate dropped below an acceptable level.

TABLE 1.6. Summary of Measurement Programs at SPO in 1993

Program	Instrument	Sampling Frequency
Gases		
CO_2	Siemans IR analyzer	Continuous
CO_2, CH_4	2.5-L glass flasks, through analyzer	1 pair twice mo^{-1}
	2.5-L glass flasks, MAKS pump unit	1 pair twice mo^{-1}
Surface O_3	Dasibi ozone meter	Continuous
Total O_3	Dobson spectrophotometer no. 82	3 day^{-1}
Ozone profiles	Balloonborne ECC sonde	1 wk^{-1}, summer, autumn, winter; 1 (3 $day)^{-1}$, spring
Water vapor	Balloonborne sonde	10 times yr^{-1}
N_2O, CFC-11, CFC-12, CFC-113, CH_3CCl_3, CCl_4	300-mL stainless steel flasks	1 sample mo^{-1}
N_2O, CFC-11, CFC-12, CFC-113, CH_3CCl_3, CCl_4, HCFC-22, HCFC-141b, HCFC-142b, CH_3Br, CH_3Cl, CH_2Cl_2, $CHCl_3$, C_2HCl_3, C_2Cl_4, H-1301, H-1211	850-mL stainless steel flasks	1 sample mo^{-1}
CFC-11, CFC-12, CFC-113, N_2O, CH_3CCl_3, CCl_4	Shimadzu automated GCs	1 sample h^{-1}
Aerosols		
Condensation nuclei	Pollack CNC	2 day^{-1}
	TSI CNC	Continuous
Optical properties	Four-wavelength nephelometer	Continuous
Solar Radiation		
Global irradiance	Eppley pyranometers with Q and RG8 filters	Continuous, summer
	Eppley pyranometer with Q filter	Continuous, summer
	Net radiometer	Continuous, summer
Direct irradiance	Eppley pyrheliometer with Q, OG1, RG2, and RG8 filters	2 day^{-1}
	Eppley pyrheliometers with Q and RG8 filters	Continuous, summer
Albedo	Eppley pyranometers with Q and RG8 filters filters, downward facing	Continuous, summer
Terrestrial (IR) Radiation		
Unwelling and downwelling	Eppley pyrgeometers	Continuous
Meteorology		
Air temperature	Platinum resistor, 2- and 20-m heights	Continuous
Pressure	Capacitance transducer	Continuous
	Mercurial barometer	1 time wk^{-1}
Wind (speed and direction)	Bendix Aerovane	Continuous
Frost-point temperature	Hygrometer	Continuous
Cooperative Programs		
CO_2, ^{13}C, N_2O (SIO)	5-L evacuated glass flasks	2 mo^{-1} (3 flasks $sample^{-1}$)
Total surface particulates (DOE)	High-volume sampler	Continuous (4 filters mo^{-1})
Various trace gases (OGIST)	Stainless-steel flasks	1 $week^{-1}$ (2 flasks set^{-1}), summer only
Interhemispheric $^{13}C/^{14}C$ (CSIRO)	5-L glass flasks	1 or 2 flasks mo^{-1}
O_2, N_2 (Scripps)	Air sampling pump and flasks	1 mo^{-1} (3 flasks set^{-1})
Isotope production (LLNL)	Pressurized cylinders	N/A; checked once mo^{-1}

TABLE 1.7. South Pole Discrete Measurements Summary for the 1992-1993 Winterover Year

	1992		1993									
	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.
CMDL Programs												
Dobson obs.	451	594	397	225	51	-	90	93	45	72	-	214
Pollak obs.	135	149	149	124	168	162	156	156	156	165	165	162
Filter wheel NIP	42	41	72	46	8							6
Smithsonian model comparison (radiation)	21	26	43	31	19							15
Meteorology obs.	30	31	31	28	31	30	31	30	31	31	30	31
CO_2 flasks T.A.	10	6	8	6	10	8	10	8	8	10	8	8
CO_2 flasks MAKS	4	4	8	2	4	4	4	4	4	4	4	4
NOAH flasks	10		6	8	10	2	2	2	2	2	2	
Balloons O_3	9	3	3	5	5	5	4	4	5	9	11	11
Balloons H_2O			1			1		2	2			1
Cooperative Programs												
CSIRO CO_2 flasks	1	2	2	1	1	2	1	2	1	2	1	1
OGC trace gases	10	6	6									6
Scripps CO_2 flasks	6	6	6	6	6	6	6	6	6	6	6	6
Scripps O_2 and N_2 flasks	3	2	3		2	3	3	2	3	3	3	2
DOE radionuclies filters	4	4	4	4	4	4	4	4	4	4	4	4

Discrete observations with the Dobson ozone spectrophotometer took place during the summer months when the sun was sufficiently high above the horizon and then in the darkest winter months during each full moon. Dobson no. 82 replaced no. 80 after extensive intercomparisons. This year marked the first year of observations with the new electronic shaft encoder and computerized data acquisition system that worked wonderfully and also drastically reduced the time required for digital transfer of data to Boulder.

The ozonesonde and water vapor programs had a very successful season despite early troubles with the ozondesonde solutions and faulty connections in the telemetry cables. On October 6, 1993, one of our ozonesondes recorded an all-time low, total ozone value of 90 Dobson units. Data from this flight were supported by Dobson observations performed on the same day.

Rubber balloons were launched from the BIT platform during the summer months. Water vapor flights and winter ozonesonde flights required the larger plastic balloons that were filled in the cargo arch and launched from the cargo yard. Launches usually occured once per week except during the months of stratospheric ozone depletion (August-November) when the schedule was changed to every 3 days.

This year several successful dual launches with the ASA Meteorological Department (MET) were completed. There are many advantages to dual launches: Helium and MET balloons are conserved, the plastic balloons reach higher altitudes than the MET rubber balloons, and flight monitoring is easier with the MET automated tracking system than with the NOAA manual system. The CMDL antenna and the ASA MET antenna coexist in the radome on top of the BIT with very few instances of interference. The only interference that occurred was during the summer months when winds were light and the MET balloon rose straight overhead, causing their antenna to point directly at ours. The two antennas cannot physically bump into each other.

Nitrous Oxides and Halocarbons Division

The two Shimadzu Mini-2 electron capture gas chromatographs were inspected and upgraded during the summer by staff from the Nitrous Oxides and Halocarbons Division, adding "watchdog valves" to the gas standards and running new sample lines up the meteorological tower. For the remainder of the year, the GCs measured one sample from the sampling stack on the CAF roof and one from the middle of the tower.

Sample flask pairs were filled with ambient air once per week during the summer and once per month during the winter.

Meteorology

A faulty power supply was the cause of questionable data during days 93212-93222. Otherwise, continuous tempera-ture, wind, and pressure data were recorded without significant problems. Manual weather observations took place daily at midnight UT and data were compared with those collected by the ASA MET Department.

Data Acquisition

This was the last year of operation for most of the CAMS units that ran continuously without unexpected problems, except for occasional eccentricities when updating the date or time.

Cooperative Programs

CSIRO. Long-term monitoring of the ratio $^{13}C/^{12}C$ in atmospheric CO_2 for use in a 2-D global carbon cycle model. One glass flask was pressurized with ambient air per month, two during even numbered months. A new (portable) pump arrived during the summer and operations were trouble-free.

OGIST. Seasonal trends in the amount of chlorine- and bromine-containing trace gases in the Antarctic. Two flasks per week were filled with ambient air. No extraordinary problems were encountered.

SCRIPPS. Long-term monitoring of CO_2, $^{13}C/^{12}C$ ratio, and N_2O. Twice per month, three evacuated glass flasks were exposed to ambient air. No significant problems occurred.

SCRIPPS. Long-term monitoring of O_2 and N_2. Three glass flasks were pressurized with ambient air once per month. Reduced flowrates and broken stopcocks were a problem at the beginning of the season, but the last several months of sampling went smoothly.

LLNL. Quantification of the production rate of radiocarbon by galactic cosmic rays. Seven air-filled cylinders were placed on platforms approximately 800 m downwind of the main station. The cylinders were inspected and cleared of snow periodically; no other operations were required.

DOE. Long-term monitoring of the spatial and temporal distribution of specific and anthropogenic radionuclides in surface air. The DOE pump ran continuously without significant problems; filters were replaced four times per month.

Miscellaneous

The University of Rome lidar and the U.S. Navy ceilometer are no longer CMDL cooperative projects, but assistance was given to the ASA science technicians with operations and maintenance of both instruments. CMDL staff recovered snow stakes throughout the year to help representatives from U.S. Army Cold Regions Research and Engineering Laboratory determine the amount of snow accumulation around the South Pole Station.

1.5. Reference

Thoning, K.W., P.P. Tans, and W.D. Komhyr, Atmospheric carbon dioxide at Mauna Loa Observatory, 2, Analysis of the NOAA GMCC data, 1974-1985, *J. Geophys. Res.*, *94(D6*), 8549-8565, 1989.